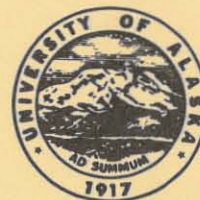


M.I.R.L. Report No. 30



REPORT OF RESEARCH PROGRESS

1971 - 1973



MINERAL INDUSTRY RESEARCH LABORATORY
COLLEGE OF EARTH SCIENCES AND MINERAL INDUSTRY
UNIVERSITY OF ALASKA
FAIRBANKS, ALASKA



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MINERAL INDUSTRY RESEARCH LABORATORY
COLLEGE OF EARTH SCIENCES AND MINERAL INDUSTRY

REPORT
OF
RESEARCH PROGRESS
1971 - 1973

MIRL STAFF
UNIVERSITY OF ALASKA
FAIRBANKS, ALASKA, 99701

July 1973

MINERAL INDUSTRY RESEARCH LABORATORY STAFF

Professional Staff

Earl H. Beistline, Director, Dean CESMI and Professor of Mining Engineering.

Ernest N. Wolff, Associate Director and Professor of Mineral Exploration,
(Full time, Part time since September 1, 1971).

P. Dharma Rao, Associate Professor of Coal Technology, (Full time).

Lawrence E. Heiner, Associate Mineral Engineer, (Full time, left M.I.R.L.
July 1, 1971).

Donald Grybeck, Assistant Professor of Geology, (Part time).

Nils I. Johansen, Assistant Professor of Geological Engineering, (Part time, joined
M.I.R.L. September 1, 1971).

Helen M. Linde, Secretary.

Research Assistants

Edwin M. Rhoads

Joseph W. Town

Associates

Chris Lambert, Jr., Head, Dept. of Mineral Engineering and Professor of
Mining Engineering.

Donald J. Cook, Professor of Mineral Beneficiation.

Herbert H. Rasche, Head, Department of Geography and Prof. of Geography.

Donald F. Lynch, Associate Professor of Geography.

Richard J. Solie, Head, Department of Economics, Professor of Economics.

Bruce I. Thomas, Mining Engineer, representing the Bureau of Mines,
U.S. Department of the Interior.

Consultants

Marvin J. Andresen, Consulting Geologist, Geonomics.

Lawrence E. Heiner, P.E.

Graduate Aid Recipients

Stephen G. Peters

Bjarne Holm

James Madonna

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THE COVER

A lone giant stripping the last bit of muck
from the cut, with a dragline standing by,
will soon be a familiar sight once again.

ORGANIZATION, PURPOSE AND FUNCTION

The Mineral Industry Research Laboratory was created by the Alaska Legislature in 1963 for the purpose of conducting basic and applied research aimed at the mineral industries in Alaska. It is part of the College of Earth Sciences and Mineral Industry. During the past year the Dean of the College acted as the Director, and there were several full time and part time professional members and a secretary. In addition, several consultants and part time workers from other departments in the University have worked on certain projects, and several students have been employed.

Although the Laboratory has cooperated closely with Federal, State, and University agencies also concerned with the mineral industries and earth sciences, it fills a unique place in that its function is specifically confined to the Alaskan scene.

Even so, the stated purpose allows a broad range of activities open to the Laboratory from coal and mineral beneficiation studies to instrument development and regional resource surveys.

A study of past mineral production for Alaska indicates that production has been erratic, but that production of non-petroleum minerals is now in a serious decline. Although the discovery and potential production of oil on the North Slope represents a tremendous step toward self-sufficiency for Interior Alaska, many economists believe that only hardrock mining, or the production of coal for export, or both, can provide the economy that will allow a stable employment environment to develop. For these reasons, most of the Laboratory's efforts so far have been connected with hardrock exploration or beneficiation, or coal utilization. As the need for research in mining methods develops, more emphasis will be directed that way.

Because of the uniquely Alaskan character of the work at the Laboratory, it is natural that service to the public is one of its important functions. Advice and information are supplied to prospectors and visitors throughout the year, and when services are unavailable elsewhere, analyses are performed.

The basic philosophy of the Laboratory can be summed up by saying that it tries to fulfill its function of fostering the Alaskan mineral industry in any way possible, among others, through research which will benefit the whole industry, by services, open to everyone, by support of theses, or by publishing works already finished.

FACILITIES

During the past three years, the Mineral Industry Research Laboratory has been housed in the Brooks Memorial Building and the Chapman Building on the University campus.

Laboratory facilities include coal testing equipment and instruments, reflecting microscope, atomic absorption spectrophotometer, emission spectrograph, x-ray equipment, and mineral beneficiation equipment recently obtained from the U.S. Bureau of Mines.

Within less than a year, the entire facility of the Laboratory will be housed on its own floor in the new Resources Building.



Display of MRL Publications, Brooks Memorial Building.

COMPLETED RESEARCH

The following projects have been completed during the past three years and reports either have been published or are awaiting publication.

FORTTRAN IV Program for Processing Geochemical Sediment Data by Lawrence E. Heiner, MIRL Report No. 23, September 1970.

The computer program described in this report will process geochemical data resulting from the analysis of up to 34 trace elements per sample. The program will:

1. Produce a table for direct inclusion in formal reports. The table contains the map number and field number of the geochemical samples, the corresponding elemental values and a table giving descriptive data about the sample. Prior to printing, the samples are arranged according to map number for easy correspondence between the table of values and the geochemical map.
2. Compute the average value for each element, normally and lognormally.
3. Compute the standard deviation for each element, normally and lognormally.
4. Compute the threshold value for each element, normally and lognormally.
5. Compute the anomalous concentrations for each element, normally and lognormally.
6. Draw lognormal or standard histograms for each element.

A Computer Processable Storage and Retrieval Program for Alaska Mineral Information by Lawrence E. Heiner and Eve Porter, MIRL Report No. 24, May, 1972.

The Mineral Industry Research Laboratory has developed a storage and retrieval file for Alaska mineral information to facilitate resource studies. The basis for the computer-processable file is the Division of Geological Survey Mineral Kardex system which contains an entry for every mineral property in Alaska that has been claimed under the mineral staking laws. Use of the file has greatly increased the research capability of the laboratory to compile resource-oriented reports such as MIRL Reports No. 16, 18, 27, and 28. The programs have been given the name MINFILE. MINFILE1 refers to a program that stores mineral information on magnetic tape. MINFILE2 is a retrieval program, MINFILE3 is a program to correct and

make additions to the file. MINFILE4 and MINFILE5 are utility programs used for maintenance of the system. This study was partially funded by the U.S. Bureau of Mines.

The report consists of two volumes, each of which can be obtained separately. Volume 1 describes the individual programs and their use. Volume 2 is a printout of all known mineral properties in Alaska. The cost is \$1.00 for Volume 1 and \$2.00 for Volume 2.

Copper Mineral Occurrences in the Wrangell Mountain - Prince William Sound Area, Alaska by Lawrence E. Heiner, Ernest N. Wolff and Donald Grybeck, MIRL Report No. 27, March 1971.

This is part of the series of MIRL publications dealing with the mineral deposits of the State of Alaska noted above. The study was suggested and financed in large part by the U.S. Bureau of Mines. The area covered is contained in the Gulkana, Nabesna, Anchorage, Valdez, McCarthy, Seward, Cordova, Bering Glacier, Blying Sound, Middleton Island, and Icy Bay quadrangles. The report contains tabulations of all copper occurrences that appear in the literature or in the claim records, with brief descriptions and references. Another table consists of a printout based on the program described in MIRL Report No. 24.

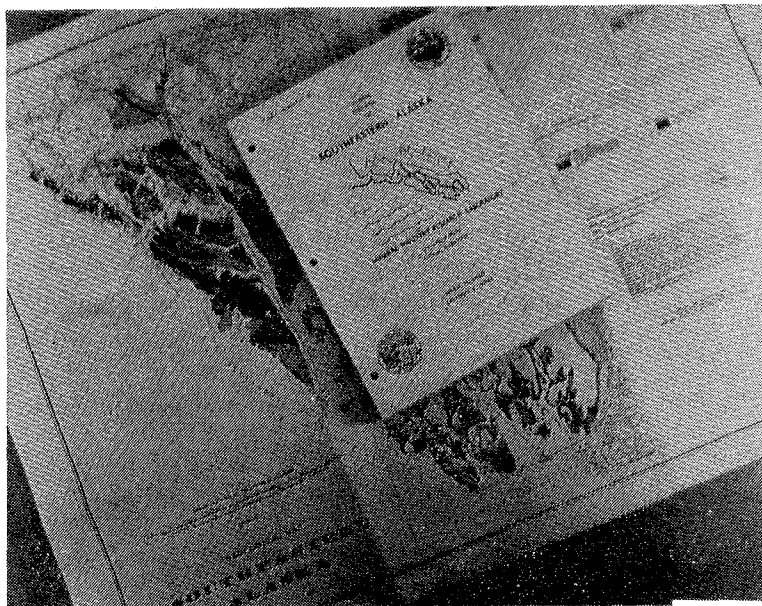
The report contains descriptions of the geography and culture as well as tectonics, geology and mining areas. There is a geologic map with overlays showing mineral occurrences, and bar graphs depicting relative abundance of different metals in different geologic formations. Each mining district is briefly described.

Mineral Resources of Southeastern Alaska by Ernest N. Wolff and Lawrence E. Heiner, MIRL Report No. 28, November 1971.

This report contains tabulations of all mineral deposits in Southeastern Alaska that are described in the literature, and is a continuation of the series already described. This report also includes the mineral commodity maps of Southeastern Alaska, previously published as MIRL Report No. 25.

In addition to the tables of mineral occurrences, a computer printout of the

Southeastern Alaska portion of the MIRL storage and retrieval program is contained in the report. Beside these tables, the following sections are included: History, Climate, Plants and Animals, Settlements, Communications and Transportation, Geography and Physiography, Regional geology of Southeastern Alaska, Igneous intrusions, Correlation of geology and ore deposits, and Production of minerals in Southeastern Alaska. An attempt is also made to construct a correlation chart of Alaskan and British Columbia formations. Translucent maps showing locations of deposits of different minerals are furnished for overlaying on a geologic map.



Optimum Transportation Systems to Serve the Mineral Industry North of the Yukon Basin by Ernest N. Wolff, Nils I. Johansen, Chris Lambert, Edwin M. Rhoads and Richard J. Solie.

This study was sponsored by the U. S. Bureau of Mines, and was completed in November, 1972. It contains a brief description of the mineral deposits, known and

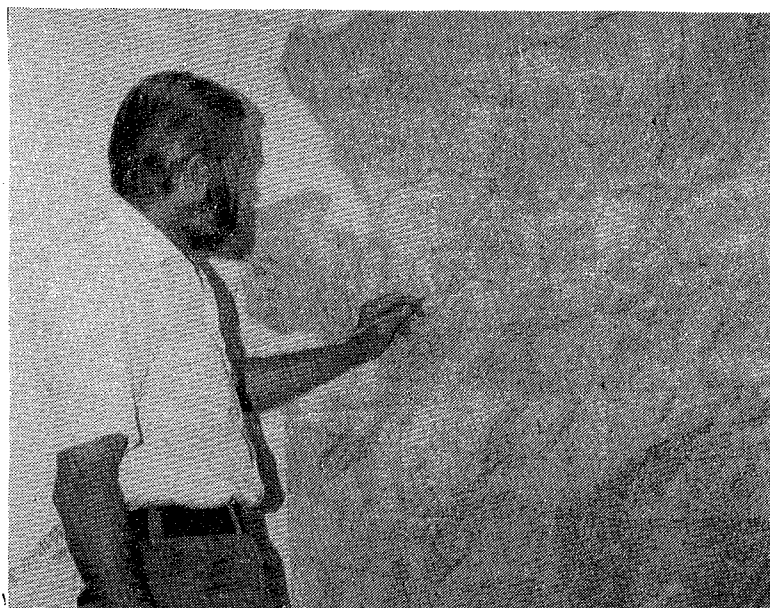
reasonably inferred, north of the Yukon. Those minerals for which a transportation system has already been decided upon were not considered. These are the Arctic petroleum and the Lost River fluorite - tin deposit.

The chief concerns of the study are the copper of the Brooks Range and the coals of the Arctic. For these, benefit-cost ratios were computed from the standpoint of the State and Federal governments. Thirty-eight segments and eighteen routes were considered in a mathematical model and those generating the highest ratio were considered worthy of further study. As would be expected, those routes requiring the least initial outlay by the State generated high benefit-cost ratios, with air and air



Developing Transportation Model.

cushion vehicles appearing quite favorable. The relative merits of these systems vs. conventional surface transportation are also considered. Other mineral deposits considered, but not put into the model are other oil basins, gold and industrial minerals. The benefits to be expected from tourism are also considered. The report will be published as MIRL Report No. 29.



Northern Transportation Network.

Minerals and United States Policy by Charles F. Park, Jr.

During the summer of 1972, several forums were held throughout the country by the National Materials Policy Commission to make recommendations for policies that would best assure that the country continue to have the minerals it needs. One of these forums was sponsored by Stanford University, where Dr. Charles F. Park, Jr., delivered a paper on mineral policy. In his paper, Dr. Park discusses the need for minerals, our growing imbalance of payments, tax policy, government aid to industries, and other political and economic aspects of mining that should be considered

by government in setting policy. Because of the importance of this statement, arrangements were made to have it published by the Mineral Industry Research Laboratory. This has been done in MIRL Special Paper No. 1, and it has been distributed free in an effort to educate the public to the great need for policies that will encourage efficiency and good conservation, while making sure that we have the minerals we need.

Solvent Extraction Procedure for the Determination of Tungsten in Ores by

P. Dharma Rao, Atomic Absorption Newsletter 9, 131-132 (1970).

Atomic absorption techniques have not been widely used for the determination of tungsten in ores due to its low sensitivity in aqueous solutions. A method has now been developed for solvent extraction of tungsten, making rapid determination of tungsten at low concentrations possible. The method involves fusion of samples in lithium metaborate and dissolution of the melt in 10% phosphoric acid. Tungsten now present as phosphotungstate is extracted into diisobutyl ketone containing 3% Aliquat 336 (methyl tricapryl ammonium chloride). Good agreement has been achieved between chemical and the solvent extraction technique.

Magnetic Separation Studies of Magnetic Iron Ores of Klukwan, by P. Dharma Rao.

A project sponsored by the Henry J. Kaiser Company was undertaken to determine the recoverable magnetic iron in drill samples. The raw samples were analyzed for acid soluble iron and TiO_2 . Magnetic iron concentrates were analyzed for acid soluble iron. Iron was determined using a stannous chloride reduction-dichromate titration method. A method was developed for atomic absorption determination of TiO_2 , as described separately in this report. A report of results was submitted to the Henry J. Kaiser Company.

Determination of Molybdenum in Geological Materials, by P. Dharma Rao, Atomic Absorption Newsletter 10, 118-119 (1971).

A new method has been developed for rapid analysis of molybdenum in ores and rock samples by atomic absorption. The method also eliminates the interfering effect of iron in the analysis. Sample is first fused in lithium metaborate and the melt is

dissolved in H_3PO_4 containing H_2O_2 , thereby bringing all molybdenum into solution as phosphomolybdate.

A liquid ion exchanger, Aliquat 336 dissolved in MIBK is used for extraction of phosphomolybdate ion into the organic phase, which is directly aspirated and analyzed by atomic absorption.



Atomic Absorption Spectrophotometer.

The Determination of Titanium in Titaniferous Magnetite Ores by Atomic Absorption Spectrophotometry by P. Dharma Rao, Atomic Absorption Newsletter, II, (49-50) 1972.

In attempting to analyze lithium metaborate fusions of titaniferous magnetite ores

from southeastern Alaska by atomic absorption, it was found that interferences due to matrix elements are not completely eliminated by any single approach suggested in the literature. A method was developed which would eliminate interferences due to the presence of silicon, iron and aluminum in the samples. Analytical procedure developed involved addition of NH_4F and SiO_2 to the samples.

Analysis of Lost River Exploration Samples for Tin, Tungsten, Beryllium and Fluorine,
by P. Dharma Rao.

A project was undertaken to analyze exploration core samples. The project was closed after analyzing 561 samples for beryllium, 130 samples for fluorine and 34 samples for tin. This work was supported by the P.C.E. Exploration, Ltd.

Zeolite Occurrences in Alaska by James Madonna.

Several zeolite occurrences have been reported in Alaska. Notable among these are: 1) metamorphic laumontite from the Chugach Mountains near Anchorage (Clark, 1972); 2) sedimentary clinoptilolite in montmorillonite clays near Umiat (Reynolds and Anderson, 1967); 3) laumontite in sandstones of the Kuskokwim area (Hoare, 1967); 4) zeolitization of the tuffs in the Talkeetna and Matanuska Formations reported by Hawkins (Personal Communication, 1973), who has identified laumontite, analcime, mordenite, and heulandite.

In the present study samples were collected from a number of promising zeolite localities in Alaska. Standard mineralogical analysis of the samples revealed two new zeolite localities. Sedimentary mordenite, clinoptilolite, heulandite, analcime, and laumontite were found as alteration products of Tertiary vitric tuffs and tuffaceous sediments of the Iliamna area. In the Mount McKinley area, mordenite was found as an amygdaloidal filling in a rhyolitic volcanic, and heulandite was found as an alteration product of a water-laid tuff. The relatively large areal extent of the highly zeolitized tuffs and tuffaceous sediments near Iliamna suggest that the deposit may be of economic importance. Localized beds, in the Mount McKinley area, containing low concentrations of zeolites, do not appear to be of economic importance. (This work was used as the basis for an M.S. thesis in the Dept. of Geology.)

Bedrock Geology of the Mount Prindle Area, Yukon-Tanana Upland, Alaska

by Bjarne Holm.

The Mount Prindle Pluton, located in the central Yukon-Tanana Upland, Alaska, was mapped as an M.S. thesis project during the 1972 field season. The project was supported by a grant from M.I.R.L. and semi-quantitative spectrographic analyses were provided by the U.S. Geological Survey.

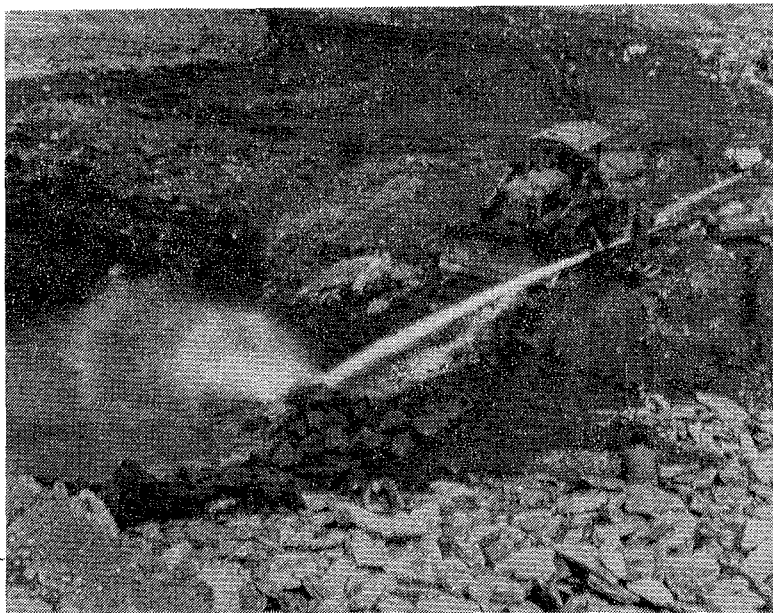
The pluton is a tourmaline and topaz bearing granite which has been emplaced during two major intrusive phases. These phases have been mapped on the basis of texture, contact and field relationships. The pluton is cut by numerous aplite and pegmatite dikes. Younger northeast trending quartz porphyry dikes cut both the pluton and the surrounding Birch Creek Schist. The pluton is also cut by three faults with a similar northeast orientation. Southeast of the pluton are two small stocks of porphyritic hornblende granite, similar to igneous rocks at the head of Sourdough and Deep Creeks. Biotite and muscovite from the pluton have yielded K-Ar dates of 58.5 ± 1.8 m.y. (minimum age) and 56.5 ± 1.7 m.y. The ages were determined by D. L. Turner at the Geophysical Institute, University of Alaska.

The placer gold mined from streams draining Mount Prindle has been introduced by the igneous intrusions. Sulphide deposits have similarly been formed. A six inch wide fluorite vein occurs near the north headwater fork of Hope Creek as a contact phase of the biotite granite. Fluorite was also found in the pluton along the southern headwaters of American Creek. However, none of the mineralization found within the Mount Prindle area appears to be of economic significance. This study was the basis for an M.S. thesis in the Department of Geology.

Recovery of Gold from Off-shore Samples

A project was sponsored by the American Smelting and Refining Company to separate and determine the gold content of bulk samples collected by the company off the Nome shore. The samples were preconcentrated at the site, and were shipped to the Laboratory in steel drums. The samples were then screened to remove coarse

rock, and tabled to reject the bulk of the gangue. The table concentrate was amalgamated and the gold was finally weighed after separating from mercury. The results were furnished to American Smelting and Refining Company.



Beneficiation of Deadwood Creek Placer Concentrate, by P. Dharma Rao .

A sample of placer concentrate from Deadwood Creek was investigated to study the possibility of recovering cassiterite. The sample as received contained 25% tin. Gravity separation followed by magnetic separation yielded a concentrate containing 47% tin. Microscopic examination of polished sections of tin concentrate revealed interlocking, showing that no improvement in grade is possible without further grinding.

Recovery of Gold from Harrison Creek Placer Concentrate by P. Dharma Rao.

A sample of placer concentrate from Harrison Creek of the Circle Mining District

was received for a study of size distribution of gold. The sample was size analyzed and the gold distribution in the various size fractions was determined. Ninety-nine percent of the gold was present between 10 and 65 mesh sizes. Tabling was found to be very effective in recovering the gold. No other valuable minerals were identified in the placer concentrate.

Distribution, Analysis and Recovery of Fine Gold from Alluvial Deposits,
(Donald J. Cook and P. Dharma Rao).

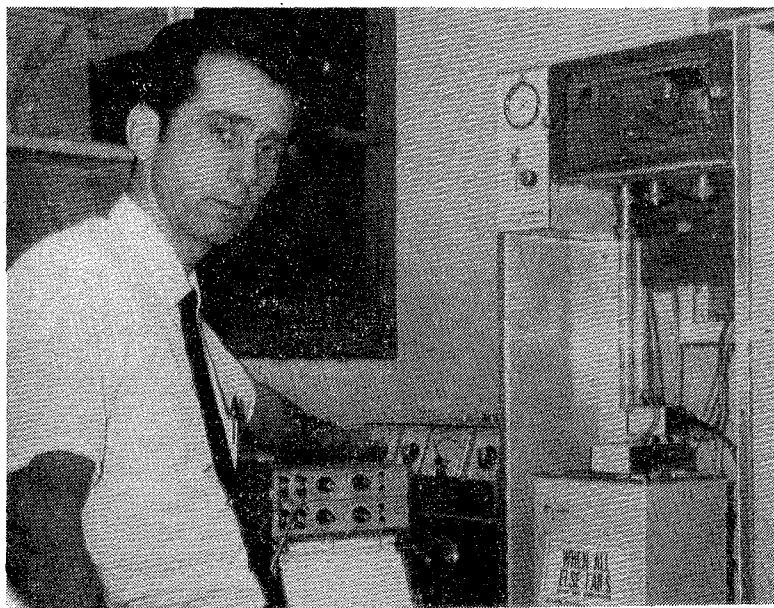
In this study fifty-three samples of alluvial material were processed to determine the size distribution of gold particles, expected losses by conventional recovery methods and accuracy of analysis and evaluation of techniques. The samples were selected to represent not only a geographical distribution, but also to cover those types of deposits in which changes could be expected in the physical characteristics of gold: creek deposits, river bar deposits, beach deposits and offshore deposits. An evaluation of shape factors of gold indicated an order of decreasing shape factor as creek deposits > river bar deposits > beach deposits. A shape factor of 0.25 was found to be a limiting value below which its recovery efficiency by conventional sluice boxes drops off rapidly. Yakataga Beach deposits with shape factors varying from .09 to 0.14 cannot be efficiently separated by gravity methods. Flotation of -28 mesh material gave recoveries of 95-100%. Flow sheets for beneficiation of each deposit is included.

A report covering the results of the investigation was submitted to the U.S. Bureau of Mines. This investigation was undertaken jointly with the Department of Mineral Engineering. Publication of the report is pending.

Mercury Distillation Studies, (Joseph H. Town and P. Dharma Rao)

Research has been completed to determine if cinnabar (mercury sulfide) can be retorted in a closed system, thus preventing the discharge of sulfur dioxide into the atmosphere; and whether cinnabar can be selectively distilled from samples containing stibnite (antimony sulfide). The study was made using two different methods of testing.

Initial tests were made using a thermogravimetric furnace (TGA) to determine the decomposition rates of a number of mercury and antimony compounds under different test conditions. This information was then used to project test conditions for a small closed retort. The retort tests showed that cinnabar can be decomposed to metallic mercury and the sulfur reacted with powdered iron (minus 40-mesh) to form iron sulfide, thus preventing the discharge of the sulfur into the atmosphere. Separation tests on cinnabar-stibnite concentrates showed that over 99 percent of the mercury can be recovered with less than 1 percent carry over of the antimony into the condenser. This study formed the basis for an M.S. thesis in the Dept. of Mineral Engineering.



Thermogravimetric Analyzer.

RESEARCH IN PROGRESS

The following projects are currently under study by the Mineral Industry Research Laboratory.

Petrographic Determination of Rank of Alaskan Coals by P. Dharma Rao.

Reflectance rank was determined for coal samples from outcrops in the Cape Beaufort region. These samples were collected by the U.S. Geological Survey during the 1970-71 field season. The samples were crushed to 20 mesh size and the particles were embedded in an epoxy resin. Polished sections of the molds were prepared. Reflectance of 50 vitrinite grains was measured using an oil immersion objective. The majority of the samples fell in the volatile "C" rank or lower, although proximate analyses indicated a much lower rank due to oxidation in the outcrops. Four of the samples showed to be agglomerating. Reflectance data on samples collected during the 1969 field season have been published in U.S. Geological Survey Open File Report, Geology and Coal Resources of T.6S., R.50 W., Unsurveyed, Umiat Principal Meridian, in the Cape Beaufort Coal Field, Northern Alaska", by James E. Callahan. The U. S. Geological Survey and the U.S. Bureau of Mines have obtained fresh samples by drilling during the 1972 field season. Reflectance rank determination of samples received so far confirms the rank as determined from outcrop samples. This verification indicates that the rank of coals from the Arctic region can be determined by reflectance measurements. In the Arctic region where the drilling season is short and expensive this is of great utility. The results will be published after all of the samples have been received and processed.

Mineral Commodity Maps, by Lawrence E. Heiner

The computer program that generated the printout described in MIREL Report No. 24 is capable of producing maps showing the distribution of deposits of any combination of minerals for any area in Alaska. Such maps have been made showing mineral deposits upon which claims had been staked as of the end of 1969. The Laboratory intends to publish these maps for all common minerals and also to show where the currently active claims are located, but is waiting until the data are up to date. The Alaska Division of Geological and Geophysical Surveys is doing this, and writing another program. As soon as these are done, the commodity maps will be published as overlays to Alaska Map E, at a scale of 1 : 2,500,000. The U.S. Bureau of Mines is sponsoring computer work and updating.

Determination of Mercury in Alaskan Coals by Flameless Atomic Absorption, by
P. Dharma Rao.

An oxygen combustion, double gold amalgamation system was constructed for the determination of mercury in Alaskan coals. The system is similar in concept to the one originally described by Joensuu (Applied Spectroscopy, Vol. 25, No. 5, 1971, pp. 526) and subsequently by O'Gorman et.al (Applied Spectroscopy, Vol. 26, No. 1, 1972). The design has been modified to make the system simpler and also versatile. Effect of operating variables on analytical results is evaluated. Higher temperatures resulted in an attack of the quartz combustion and catalytic section and is found responsible for mercury memory effects. The system is under development.

Possible Economic Zeolite Deposits on the Northern Alaska Peninsula, by
James Madonna.

Elsewhere in this report a brief description is given of the search for and identification of areas of zeolite mineralization. The most important appearing of these areas, in the Iliamna area, has been chosen for further study, and more detailed mapping is now in progress.

In addition to the above three continuing projects, the Laboratory is under contract with the U. S. Bureau of Mines to work on five projects. Work on these is just beginning, so no description of results can be made at this time. The five are listed below:

- 1) Constraints on the Development of Coal Mining in Arctic Alaska Based on Review of Eurasian Arctic Practice.
- 2) Cost of Exploration for Metallic Minerals in Alaska.
- 3) Behavior of Mine Tailings in Arctic and Subarctic Environments.
- 4) Factors Affecting Cost of Mining in Alaska.
- 5) Mining in Alaska, Environmental Impact and Pollution Control.

FINANCES

The Mineral Industry Research Laboratory has been funded both by State appropriations through the University of Alaska budget, and also by outside contracts and grants.

	FY 1970-71	FY 1971-72	FY 1972-73
State Appropriations	\$ 95,600	\$ 86,500	\$ 91,800
Contracts and Grants	\$ 5,400	\$ 36,100	\$ 74,927
Total	\$ 101,000	\$ 122,600	\$ 166,727

List of Contracts and Grants

FY 1970-71

U.S. Department of Interior, U.S. Bureau of Mines - Mineral Occurrence File	\$ 4,400
Pennzoil United, Inc. - Mineral Occurrence File	500
U.S. Geological Survey - MRL Coal Laboratory	500
	\$ 5,400

FY 1971-72

Henry J. Kaiser Co. - Magnetic Separation Studies	\$ 7,400
Henry J. Kaiser Co. - Klukwan Samples	700
U.S. Bureau of Mines - Mineral Deposits Statistical Data Gathering	3,000
U.S. Bureau of Mines - Optimum Transportation System for Mineral Occurrences North of the Yukon River in Alaska	25,000
	\$ 36,100

FY 1972-73

ASARCO - MIRL - Sample Concentration	374
U.S. Bureau of Mines - Updating Mineral Occurrence File	3,000
U.S. Bureau of Mines - Mining in Alaska, Environmental Impact and Pollution Control	12,000
U.S. Bureau of Mines - Constraints on the Development of Coal Mining in Arctic Alaska Based on Eurasian Arctic Practice	24,553
U.S. Bureau of Mines - Cost of Exploration for Metallic Minerals in Alaska	10,000
U.S. Bureau of Mines - Behavior of Mine Tailings in Arctic and Subarctic Environments	15,000
U.S. Bureau of Mines - Factors Affecting Cost of Mining in Alaska	10,000
	<hr/>
	\$74,927

LIST OF M.I.R.L. PUBLICATIONS

* Out of Print.

* ANNUAL REPORT OF RESEARCH PROGRESS by M.I.R.L. Staff, M.I.R.L. Report No. 1.

*THE MARKET POTENTIAL FOR ALASKAN CLAY PRODUCTS by Charles A. Beasley, M.I.R.L. Report No. 2, January 1965.

*ALASKAN CEMENT MARKETS AND OPPORTUNITIES FOR REGIONAL PRODUCTION, published as Research Monograph No. 4 by the Institute of Business, Economics and Government Research of the University of Alaska in cooperation with M.I.R.L., February 1965.

*PETROGRAPHIC EVALUATION OF COKING POTENTIAL OF SELECTED ALASKAN COALS AND BLENDS by Fred C. Hankinson, M.I.R.L. Report No. 3, February 1965.

*MARKET FOR INSULATION IN ALASKA AND FEASIBILITY OF REGIONAL MANUFACTURE by Robert E. Haring and Charles A. Beasley, M.I.R.L. Report No. 4, 1965.

*ANNUAL REPORT OF RESEARCH PROGRESS 1965 by M.I.R.L. Staff, M.I.R.L. Report No. 5, January 1966.

INVESTIGATIONS OF LIGHTWEIGHT AGGREGATES IN ALASKA by Lawrence E. Heiner and Alvin N. Luskamp, M.I.R.L. Report No. 6, December 1966.

*ANNUAL REPORT OF RESEARCH PROGRESS 1966 by M.I.R.L. Staff, M.I.R.L. Report No. 7, January 1967.

*NATURAL RESOURCE BASE OF THE FAIRBANKS NORTH STAR BOROUGH by Ernest N. Wolff and Robert C. Haring, M.I.R.L. Report No. 8, March 1967. With the Institute of Social, Economic and Government Research.

*FORTRAN IV TREND--SURFACE PROGRAM FOR THE IBM 360 MODEL 40 COMPUTER by Lawrence E. Heiner and Stephen P. Geller, M.I.R.L. Report No. 9.

TRACE ELEMENT COPPER DISTRIBUTION AND AREAL GEOLOGY IN A PORTION OF THE CLEARWATER MOUNTAINS, ALASKA by Paul S. Glavinovich, M.I.R.L. Report No. 10, May 1967. ✓

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